

【Grant-in-Aid for Scientific Research (S)】

Broad Section G



Title of Project : Analysis of signal transduction of stomatal movements and regulation of plant growth

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Keyword : Stomata, Signal transduction, photosynthesis, growth, drought resistance

【Purpose and Background of the Research】

Stomata open in response to light, including blue and red light. Red light induces stomatal opening via photosynthesis in the mesophyll and guard cell chloroplasts. In contrast, blue light as a signal induces stomatal opening. Phototropins expressed in guard cells act as major blue light receptors for stomatal opening. Blue light-induced stomatal opening is mediated through activation of a plasma membrane (PM) H^+ pump, later identified as the PM H^+ -ATPase, in guard cells. The blue light-activated pump provides driving force for stomatal opening concomitant with ion accumulation and cell volume increase in guard cells. However, the detail molecular mechanism of stomatal movements is still unknown.

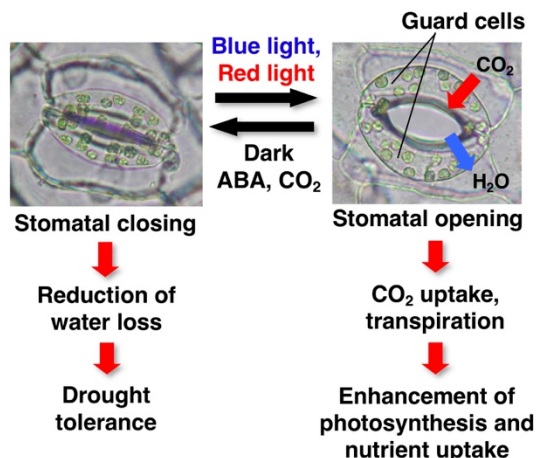


Figure 1 Stomatal movements and functions

【Research Methods】

To elucidate the signal transduction for stomatal movements, we are planning to perform 2 projects, as follows.

1, Identification of protein kinase and protein phosphatase, which regulate phosphorylation status of PM H^+ -ATPase, in stomatal guard cells. We have screened protein kinase and protein phosphatase library and found several candidate inhibitors. We are going to identify these target components, which bind to these inhibitors, by genetic and biochemical approaches.

2, Identification of the novel signal components involved in stomatal movements. We have started comprehensive chemical screening to identify the chemicals, which affect stomatal opening and closing, and genetic screening to

find the mutants, which defect light-induced stomatal opening. We are going to identify and clarify the function of these components in the signal transduction in stomatal guard cells.

Based on the results from these basic researches, we will try to manipulate stomatal aperture by transgenic techniques, but also chemical treatment and investigate stomatal phenotype, photosynthetic activity, plant growth, and drought resistance.

【Expected Research Achievements and Scientific Significance】

Stomata open in response to blue light to facilitate gas exchange between the plant and the atmosphere. This response is key to terrestrial plant life, as gas exchange is necessary not only for photosynthesis but also for water uptake from the roots. It is important to elucidate the signal transduction in stomatal guard cells in response to environmental signals for biological science.

Given the importance of stomatal function, future investigations will not only improve our understanding of the molecular mechanisms of signaling pathways in plants, but also provide important clues for agricultural strategies to improve photosynthetic or water use efficiency, leading to an increase in the biomass and harvest of crops.

【Publications Relevant to the Project】

- Inoue S, Kinoshita T. (2017) Blue light regulation of stomatal opening and the plasma membrane H^+ -ATPase. *Plant Physiology*, 174, 531-538.
- Wang Y, Noguchi K, Ono N, Inoue S, Terashima I, Kinoshita T (2014) Overexpression of plasma membrane H^+ -ATPase in guard cells promotes light-induced stomatal opening and enhances plant growth. *Proc. Natl. Acad. Sci. USA*, 111, 533-538.

【Term of Project】 FY2020- 2024

【Budget Allocation】 143,800 Thousand Yen

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